International Journal of Computer Science Engineering
and Information Technology Research (IJCSEITR)
ISSN(P): 2249-6831; ISSN(E): 2249-7943
Vol. 5, Issue 5, Oct 2015, 43-52

PERFORMANCE COMPARISON OF PATH LOSS SENSITIVE ROUTING PROTOCOL AND MULTIPATH ROUTING PROTOCOL FOR MANETS

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ABSTRACT

A Mobile Ad hoc network is infrastructure less network which is dynamic in nature. It contains set of portable devices which are mobile and self-organizing. Various constraints like dynamic topology limited and shared bandwidth and limited battery power makes task of designing a mobile ad hoc network challenging. The topology of a mobile ad hoc network continuously change as it is mobile in nature. Due to such frequent movement of node the route from source to destination may also break. The route discovery procedure is initiated as the route breaks. The frequent discovery of route increases the routing overhead and delay. The existing routing protocol does not take in its consideration the stability of the wireless link and merely based on hop count metric. If the route is found by considering the stability of links, the route may remain active for long time. The provision of multiple paths may also achieve good performance compared to a single path. In this paper we compare performance of path loss sensitive AODV which considers path loss in order to find a route and AOMDV which finds multiple paths in a single route discovery.

KEYWORDS: MANET, Routing, Stability, Cross-Layer, Path loss, AODV

INTRODUCTION

A Mobile ad hoc network is set of devices which communicate without any infrastructure support. The devices in Mobile ad hoc network can move in any direction. There is no central control available in mobile ad hoc network. Each device should be capable to handle the traffic without any infrastructure support. Routing related information is maintained by each device so that they can properly route the traffic. Another characteristic of mobile ad hoc network is its dynamic topology. The mobile devices continuously change their location so that topology of the network also changes [1].

Efficient delivery of data packets is very challenging task in MANET due to its dynamic topology and lack of centralized control. Hence, routing in ad-hoc networks can be viewed as a challenge.

The routes are created on requirement basisin on-demand or reactive MANET routing protocols. Whenever there is a need to found a route the route discovery procedure is initiated. The routing tables of on-demand routing protocols maintains only those routes that are currently in use. They maintain low control overhead since a small subset of all available routes is in use at any time [1].

There is only one route maintained between source and destination pair in existing routing protocols of ad-hoc networks. A link in a route can become temporarily unavailable due to node mobility and dynamic topology, which can make route invalid [1].

As the route becomes invalid the route discovery procedure is initiated to find an alternative route, which can increase routing overhead and packet delivery delay. The solution to this problem is to use multiple paths between source and destination node pairs, where one route can be used as the primary route and the rest as backup. Performance can be adversely affected by high route discovery latency and frequent route discovery in dynamic networks. This can be reduced by computing multiple paths in a single route discovery attempt. Multiple paths can be formed for both traffic sources and intermediate nodes with new routes being discovered only when needed, reducing route discovery latency and routing overheads. Multiple paths can also balance network load by forwarding data packets on multiple paths at the same time.

The other way of reducing the routing overhead is to find a route which remains active for longer time. A more stable path could be found that would reduce the number of route failures. A stable route would lead to less number of route discoveries and in turn reduce the routing overhead.

In this paper, we compare two approaches

- Path loss sensitive reactive routing protocol with stable route
- Multiple paths in reactive protocol

For our purpose we use path loss sensitive AODV which finds a stable path by considering path loss and AOMDV which is an extension of AODV with provision of multiple paths.

BACKGROUND

Reactive routing protocols works on the principle of on- demand route discovery creating routes as and when required between a source and destination node pair in a network topology. Our discussion is limited to two on-demand ad-hoc routing protocols, AODV and AOMDV, as follows.

Ad-Hoc on-Demand Distance Vector Routing (AODV)

AODV is an on demand routing protocol for mobile ad hoc network. It only discovers a route as and when it is required. As it discovers route on demand basis it is also called reactive routing protocol. When any node wants to send data packet to any other node it initiates route discovery procedure. RREQ (route request) packets are sent by the sender to its neighbours as a part of route discovery procedure. Each node which receives RREQ packet also forwards that packet to its neighbours. The RREQ packet finally reaches to the destination. The destination node sends RREP packet towards sending node as a response to the RREQ packet. Upon receiving the RREP packet sender stores the route related information in routing table [11].

Each node also maintains neighbour table (NT) and list of precursor. The neighbour table contains list of nodes which are within reach of the current node. The precursor list contains list of all nodes that precede the current node in the active route. The precursor list can be useful in the event of link failure. The node which detects link failure send RERR (route error) packet to its precursor. The precursor node send RERR packet to its precursors in turn by erasing the entry in the route table for current route. Sequence numbers are used to maintain the freshness of route. AODV requires less memory space but not scalable in large networks [11].

Ad-Hoc on-demand Multipath Distance Vector Routing (AOMDV)

Ad-hoc on-demand Multipath Distance Vector Routing protocol (AOMDV) is an extension of AODV with

provision of multiple paths [12]. It has provision of alternative or back up route along with active route. The routing table is equipped to maintain more than on entry for the same route. Each node maintains list of next hop node for a single route. AOMDV finds multiple routes for a single source-destination pair such that the routes are link-disjoint. AOMDV uses concept of advertised hop count to make the route loop-free. Advertised hop count is nothing but maximum no of hops for destination. Destination node sends RREP to each duplicate route discovery in order to find multiple paths. The alternative paths are only considered valid if their hop count is less than advertised hop count. When route discovery procedure is reinitiates with new sequence number advertised hop count is recalculated.

Multiple RREQs may arrive at the destination but it replies to only those RREQs which arrive via different neighbours. Intermediate nodes also forwards duplicate RREQS if they have arrived from different neighbours of the source. Any two RREQs arriving at an intermediate node via a different neighbour of the source could not have traversed the same node. The RREQs are forwarded such that it yields node-disjoint paths. Destination sends multiple RREPs in response to RREQ packets. Each RREP packet may traverse through same intermediate node but follows different reverse path. AOMDV finds node-disjoint paths which are also link-disjoint [12]. The need to find multiple routes increases the routing overhead in AOMDV. On the other hand in the event of route failure alternative route can be very useful [12].

RELATED WORK

Approaches to find a Reliable Route Path

The reliable route for mobile ad hoc network can be found by using multiple approaches [2]. There are various routing protocols for mobile ad hoc network which uses different parameters to achieve reliable route. Some protocol uses available energy of the node, while some considers received signal strength. Link available time (LAT) or link expiration time can also be a good parameter to find a stable route.

Choosing Received Signal Strength as a Parameter for Stability

Reliable routing protocols for mobile ad hoc network find a route with minimum number of hops. There are chances that there are weak link in routing protocol for MANET. Parameter other than hop count can improve the stability of route. If received signal strength is used as a metric to find a route, the resulting route can remain active for long time [6].

Cross-Layer Design

Cross-layer design can be utilized if we need to share the information between multiple layers. In [4] received signal strength measured at physical layer is used at routing layer to make routing decision. The cross-layer design can also share some other parameters within network layers. Various parameters can be utilized at different layer for the betterment of the network.

AODV is an on demand routing protocol for mobile ad hoc network. Route discovery procedure sends RREQ packets to initiate route discovery. AODV finds a route such that it contains minimum number of hops, so there are chances of weak links. There is a need to find a route which has a long lifetime. Such a stable route can be found by utilizing received signal strength of RREQ packet. The received signal strength measured at physical level canbe used to make routing decisions at network layer [4]. To avoid weak links in route the receiving node avoids forwarding RREQ packet which has poor received signal strength. To check whether the RREQ packet has good received signal strength or not it can be compared with a predetermined threshold to. The threshold can be a fixed threshold or an adaptive threshold

whose value changes with changing speed of the nodes. The adaptive threshold also adapts to moving direction of the nodes.

The received signal strength can also be used to calculate path loss of the link. The same information can be made available to routing layer by cross-layer approach to make routing decision[3]. The path loss information is calculated for each link. To find the total path loss of entire route the path loss measured for each link of route is added. The total path loss of the route is then divided by number of hops to find average path loss. Only the route which is having lesser average path loss can be selected, so resulting route can be more stable.

The received signal strength can also be used to estimate link available time (LAT) [5]. The AODV-RSS determines paths that are long lived means, a route that can sustain for a longer time. In AODV-RSS the Received Signal Strength (RSS) and Received Signal Strength changing rate (Δ RSS)is used to predict the link available time (LAT) between two mobile nodes. Only those links which has better link available time (LAT) can participate in formation of route. AODV-RSS can improve the route quality due to good route connection time and good route reestablishment frequency.

The Route Stability based QOS Routing (RSQR) protocol is an extension of QOS routing with added stability feature along with throughput and delay constraints [7]. Firstly, it considers node mobility and signal strengths for computing the probability of link failure rather than using probability distribution of link lifetimes. In order to guarantee the suitable path for adequate longer duration in MANET, an easy model has been proposed for measuring the link stability and route stability depending on received signal strength. RQSR has provision of some additional fields in route request/ reply packets to store the route stability information. All possible paths are compared and route with increased stability is chosen.

PATH LOSS SENSITIVE STABLE ROUTING PROTOCOL

AODV is a reactive or on-demand routing protocol for mobile ad hoc network. RREQ (route request) packets are broadcasted to neighbours whenever there is a need to find a route. After checking the destination address neighbouring nodes forward RREQ packet to their neighbours. RREQ packets traversing from different path arrives at the destination and RREP (route reply) packet is sent for the first RREQ that reaches the destination. A minimum hop path is selected as a route [11]. AODV finds such a route which contains minimum number of hops and having weak links which may lead to frequent route failures [6]. whenever the active route fails route discovery procedure is initiated, such frequent route discoveries increases routing overhead of the network.

The path loss sensitive stable routing protocol is a Cross-Layer routing protocol which uses path loss as a parameter to achieve stable route [14]. The received signal strength measured at physical layer is made available at network layer. The path loss of the link is determined by subtracting received signal strength from transmit power. Received signal strength of each RREQ packet is measured at each node. The path loss for each RREQ packet is determined and it is forwarded only if the link has sufficient path loss. So, the links with large path loss will not participate in formation of the route.

A predetermined threshold is used decide whether the link has the sufficient path loss or not. The threshold to be used can be a fixed value or it could be changing adaptively with changing network condition. Fixed threshold design compares path loss of link with predetermined threshold which is the desired value of the path loss as shown in Figure 1.

The RREQ is only forwarded if the path loss of the link is greater than the threshold, so links having high path loss may not participate in formation of route. The route determined by using fixed threshold method can remain active for long time, which provides stability. The stable route can reduce link failures and in turn it will also reduce number of route discoveries. Overall performance achieved by fixed threshold may not be satisfactory due to increase no of hops in stable route. The increased no of hops increases the end to end delay and reduces the throughput of the network. The fixed threshold does not consider the moving direction of sending and receiving node.

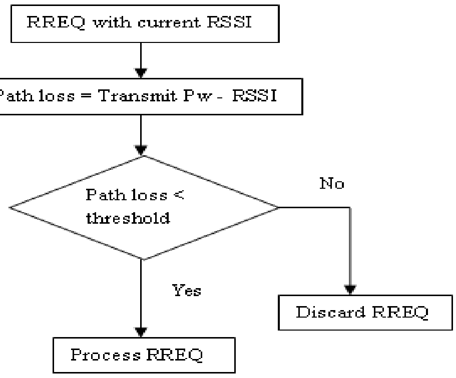

Figure 1: Flowchart for Finding Stable Path using Path Loss as a Parameter

Performance is further improved by using different threshold values with respect to different speed of mobile nodes. As shown in Figure 2 the adaptive threshold version improves the design of fixed threshold by considering moving direction of the node. When RREQ is received by the node it calculates the path loss and stores that in neighbour table. Each node thus maintains the previous path loss information of their neighbours. If the current path loss measured from RREQ is less than the previous path loss the direction of node is considered as approaching. if current path loss is greater than previous RREQ the nodes are considered as moving away.

Path loss of the link is calculated using the received signal strength whenever nodes receive RREQ from the neighbours. The calculated path loss is checked against a threshold. If the path loss is greater than the threshold but the nodes are approaching then nodes will forward the RREQ. If the path loss is greater than the threshold but the nodes are moving away from each other than the nodes discards the RREQ. If the path loss is greater than the threshold then the nodes forwards RREQ. The current path los is also stored in Neighbour table (NT) in any case.

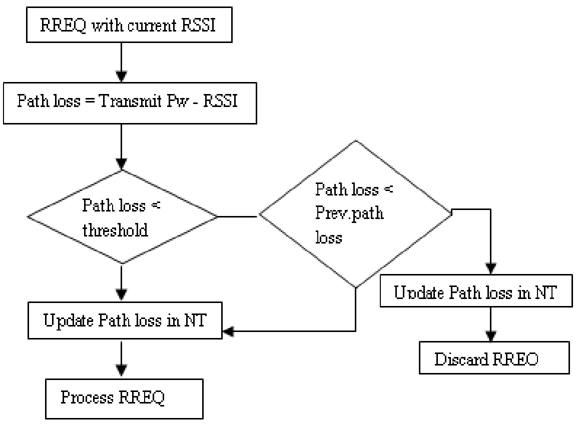

Figure 2: Flowchart for Finding Moving Direction of Mobile Nodes using Path Loss of the Link

SIMULATION ENVIRONMENT AND RESULT ANALYSIS

There are various simulators available to simulate mobile ad hoc network. Network Simulator 2 (NS2) has a support for simulating a multi-hop wireless ad-hoc environment. We have used NS 2.34 for simulating Path loss sensitive AODV as well as AOMDV.49 nodes are deployed in an area of 1000 × 1000 m^2. Each point in result is an average of 10 seeds. The other simulation parameters are summarized in table I.

We tested following three cases

- AODV with path loss and Fixed Threshold (AODV Fixpath).
- AODV with path loss and adaptive threshold which considers moving direction of nodes (AODV Adpath).
- AOMDV.

The fixed threshold value of 200 (path loss which is measured after traveling 200 meters) is used for “AODV Fixpath” and it is tested for different speed in the range of 5 m/s-25 m/s.

The different threshold values (230 m, 210 m, 200 m ,187.5 m, 162.5 m) are used for “AODV Adpath” for the speeds (5 m/s, 10 m/s, 15 m/s,20 m/s, 25 m/s) respectively. In addition to that it also considers the moving direction of the mobile nodes.

Table 1: Simulation Parameters

Parameters	Values
Transmission range	250 meter
Mobility model	Random Way point
Propagation model	Two Ray Ground
MAC Layer	802.11
Simulation time	200 sec
Transmission Protocol	TCP
Routing Protocol	AOMDV, AODV Fixpath and AODV Adpath.
Packet size	512 Bytes

Packet Delivery Ratio

We can observe the performance of AODV Fixpath, AODV Adpath and AOMDV in terms of packet delivery ratio from Figure 3. Both AODV Fixpath and AODV Adpath is having better packet delivery ratio compared to AOMDV. AODV Adpath considers moving direction which further improves the performance than AODV Fixpath

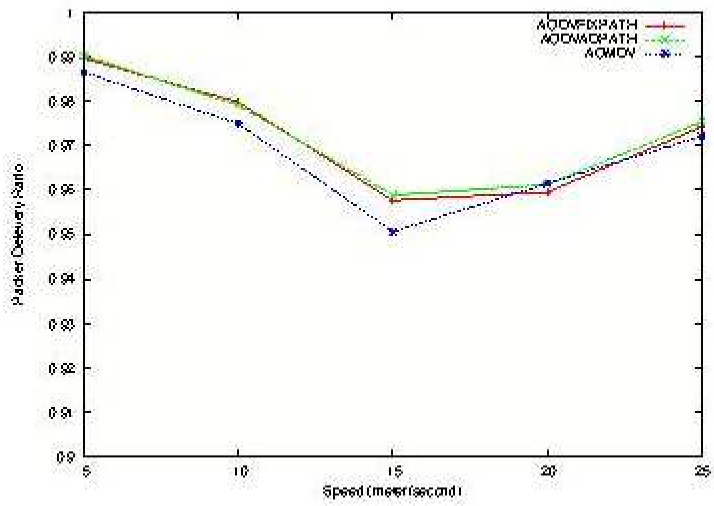

Figure 3: Shows Packet Delivery Ratio against Different Speeds of Mobile Nodes

Normalized Routing Load

Figure 4 shows performance of AODV Fixpath, AODV Adpath and AOMDV in terms of routing load. Both AODV Fixpath and AODV Adpath find a single route which is reliable. The reliable route reduces frequent route discoveries and in turn reduces routing overhead of the network. AOMDV on the other hand uses multiple paths and does network wide broadcast to find them. Thus AOMDV has more routing overhead compared to both AODV Adpath and Fixpath.

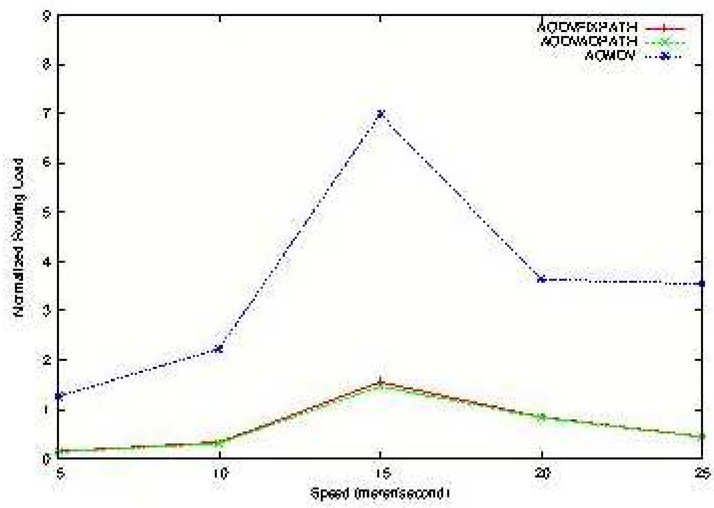

Figure 4: shows normalized routing load by varying the speeds of mobile nodes.

Average end to End Delay

Figure 5 shows performance of AODV Fixpath, AODV Adpath and AOMDV in terms of average end to end delay. AOMDV maintains multiple paths so that alternative paths can be used in event of route failures. The provision of alternative route reduces delay occurred in finding new route. As it can be observed from figure AOMDV has comparatively less end to end delay than both AODV Adpath and Fixpath.

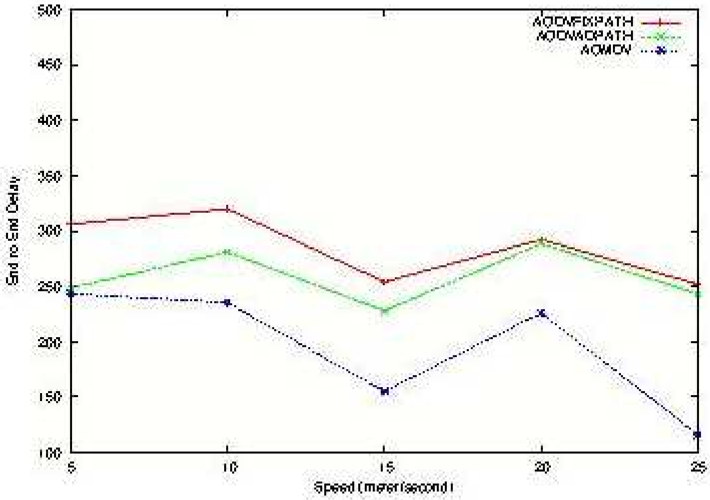

Figure 5: shows average end to end delay occurred at different speed of mobile nodes.

Throughput

Figure 6 shows performance of AODV Fixpath, AODV Adpath and AOMDV in terms of throughput. Both the versions of AODV has good throughput compared to AOMDV. AOMDV has good end to end delay but higher routing load. On the other hand AODV Fixpath and AODV Adpath has comparatively lesser routing load.

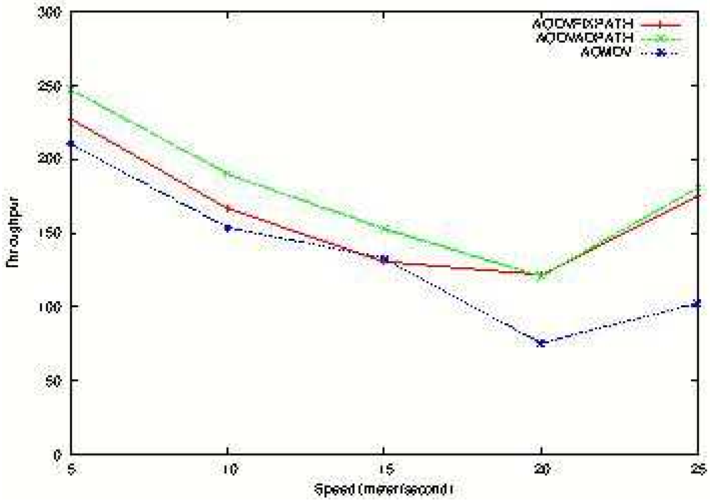

Figure 6: Shows throughput by Varying the Speed of Mobile Nodes

CONCLUSIONS

We have evaluated performance two versions of path loss sensitive AODV with performance of AOMDV protocol in this paper. It can be observed from results that AOMDV has lesser average end to end delay compared to path loss sensitive AODV. AOMDV also reduces route discovery latency because it is having multiple paths. When the active route breaks the network can switch on tothe alternative route.

AOMDV does network wide broadcast of RREQ packets in order to find multiple paths in single route discovery.

The flooding of RREQ packet increases the routing load of the network. In both the variants of path loss sensitive AODV unnecessary RREQ packets are dropped which reduces the routing load of the network. Due to reduced routing load both the variants of path loss sensitive AODV achieves better packet delivery ratio and throughput than AOMDV.

If End to End Delay is of our concern than we can choose AOMDV but, if routing overhead is our concern then we can choose path loss sensitive AODV which reduces the routing load of the network.

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